Small Business Innovation Research/Small Business Tech Transfer

ACE Booster, Phase II

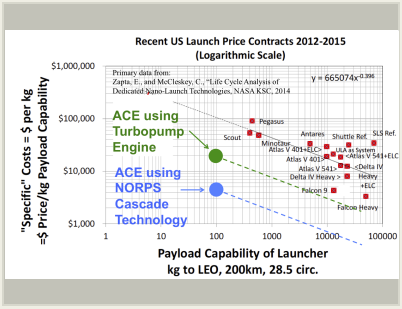
Completed Technology Project (2015 - 2017)

Project Introduction

GTL has been developing a suite of transformational technologies that have the capability to disrupt the traditional launch vehicle paradigm. BHL composite cryotank technology provides a four times improvement over large aluminum iso-grid tanks, offering a 6 percentage point improvement in small stage PMF. Superior Stability Engine is an innovative liquid rocket engine configured to maximize combustion stability margin while also maximizing engine performance. NORPS is a non-helium gas generator system that can be used to pressurize the propellant tanks for 1/3 the mass and 1/10 the volume of a comparable helium based system. Using these and other technologies, GTL has developed the conceptual design for the Advanced Cryogenic Expendable (ACE) nano-launch vehicle. The 7700 lb gross lift-off weight ACE vehicle is capable of delivering a 154 lb payload to 400 nmi circular orbit at 28.5 deg inclination. With a launch cost of less than $1M at low launch rate, ACE is directly competitive with existing large launch vehicles on a $/lb basis. This affordability is enabled by a combination of high performance, reduced stages and parts count, and simplified operations. The proposed Phase II effort will seek to reduce the ACE vehicle development risk by increasing the technology readiness level of critical technologies. Specifically, GTL will fabricate and test a prototype NORPS gas generator and pressurization system. Along with this, GTL shall fabricate a full-scale BHL composite cryotank for use in the system testing using modular manufacturing techniques. The integrated system shall be tested for operational capabilities to demonstrate the effectiveness of the technology and optimize the system design. The data from these tests will be used to refine and optimize the design of the ACE vehicle.

Anticipated Benefits

The ACE nano-launch vehicle offers small payload launch capability for a cost that is competitive on a $/kg basis with that of large launch vehicles. This represents more than an order of magnitude improvement in affordability over what can be achieved with existing small launch vehicles. This launch capability would provide NASA with the means to affordably launch numerous small scientific and exploratory spacecraft, without having to bundle them together on large launch vehicles. This will provide NASA with enhanced flexibility in mission design that will increase space mission effectiveness. When the ACE vehicle design is eventually scaled to heavy-lift size, the cost of payload delivery to orbit would be reduced to less than $500/kg to LEO. This would represent an order of magnitude improvement in affordability compared to existing large heavy-lift launch vehicles. This level of launch affordability would enable large scale access to space that would facilitate permanent habitation of the Moon and Mars. In the near term, the suite of ACE technologies can be used to upgrade NASA space systems. For instance, the NORPS non-helium pressurization system could be used to reduce helium use on Orion and SLS. The high performance BHL cryotanks could be used to



ACE Booster, Phase II Briefing Chart Image

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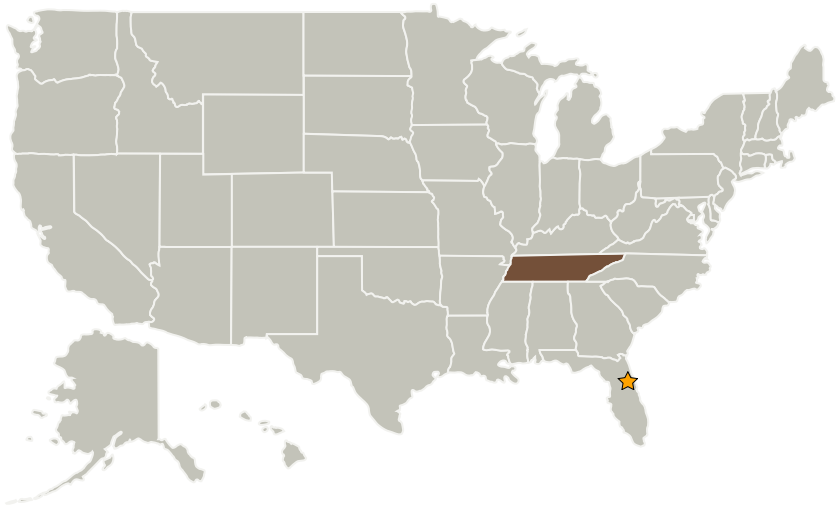
improve performance of SLS and other NASA vehicles under development. The Superior Stability Engine technology could be used to reduce development costs for new NASA engines.

The ACE nano-launch system would provide commercial and DoD customers with an affordable means to launch small payloads to orbit that is competitive with large launch vehicles. As a small launch vehicle with the capability of austere operations, ACE can be used to provide DoD with tactical launch capability that can be used to increase resiliency of US military space assets. Additionally, the affordability of ACE would allow it to be adapted for weapons delivery, thereby providing low-cost global strike capability. The suite of ACE technologies can be used to upgrade commercial and DoD space launch systems. Several commercial launch vehicle developers are already considering BHL cryotanks for their vehicles. The Air Force is currently considering the UCDS and SSE technologies for insertion into their Oxygen Rich Staged Combustion engine development effort. The Missile Defense Agency is considering using the UCDS technology to improve the stability and performance of missile defense systems.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

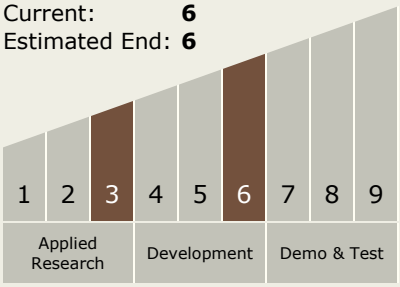
Carlos Torrez

Principal Investigator:

Paul Gloyer

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Gloyer-Taylor Laboratories LLC	Supporting Organization	Industry	Tullahoma, Tennessee
University of Tennessee Space Institute	Supporting Organization	Academia	TULLAHOMA, Tennessee

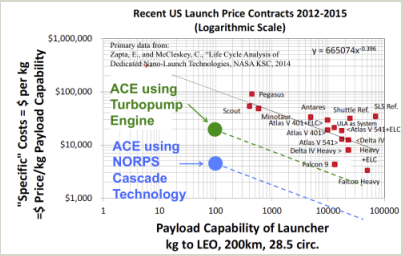
Primary U.S. Work Locations
Tennessee

Project Transitions

May 2015: Project Start

June 2017: Closed out

Images



Briefing Chart Image
ACE Booster, Phase II Briefing Chart Image *(https://techport.nasa.gov/image/30134)*

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.2 Launch Vehicle Propellant